A Simple, Neutral Building Data Model

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ABSTRACT: A growing number of building simulation tools exists in France and elsewhere. These tools serve different purposes: building code compliance (RT 2005), energy performance optimization, proof of concept, etc. As a consequence, often the same actors have to input the same building into different tools. Originally (before 2007), most of the building simulation tools commonly used in France did not include any mechanisms to exchange project data. Only one tool is able to read IFC data files (a global approach aiming at connecting a huge variety of tools); the implementation of full IFC compliance is considered too complex / costly by the small editors of the other tools.

In this situation, a very simple, easy-to-implement, solution has been proposed in the form of the NBDM – a Neutral Building Data Model. Much less ambitious than the IFC approach, it captures the essentials of a thermal building product model in less than 20 classes. While such 'insular' solutions could be considered against the 'IFC spirit', we feel that the introduction of such 'small scale data models' will help to better connect software tools which do not have the critical mass to support 'complete' (complex) data models, but are still critical to our industry. At the same time, such initiatives prepare a future connection of these islands to more global approaches such as the universe of the IFC data model.

This approach is totally in line with the global effort of building energy performance improvement. We seek to reduce the consumption by studying several parameters (insulation, energy management, …) or to obtain better summer comfort conditions (solar mask efficiency, …) by turning independent tools in to a chain of collaborative tools.

1 INTRODUCTION TO NBDM

NBDM 1.0 is an object oriented data model which uses the XML syntax for physical project data files. Its main characteristics are:
- Covers thermal building simulation only
- No detailed geometrical model (only orientations (North, 43.5° west…) are given; version 1.2 added surface vectors, which are however only used for a graphical representation of the building (currently not destined for calculation)
- *Extremely* simple to describe, understand and implement (uses less than 20 classes (entities / types of objects), can be fully explained in less than 1 hour)
- Extensible (new concepts have already been successfully added since version 1 has been implemented and used)

The NBDM data model has been successfully implemented in the following major French and international building simulation tools: ClimaWin, CODYBA, COMFIE, and TRNSYS (a general simulation environment containing a detailed building model). It is currently being used and tested in real-world projects. Other links are in preparation.

2 NBDM AND IFC

In his thesis, Treldal (2008) analyzed how input and output of five simulation tools[1] can be defined in IFC or derived from IFC. The average values of data covered are respectively 42% and 28%. This means that 70% of data match directly or indirectly with the IFC model. 88% could be achieved creating few new property sets and adding some properties to existing property sets.

[1] iDbuild, Riuska, BSim, Be06 and Flovent

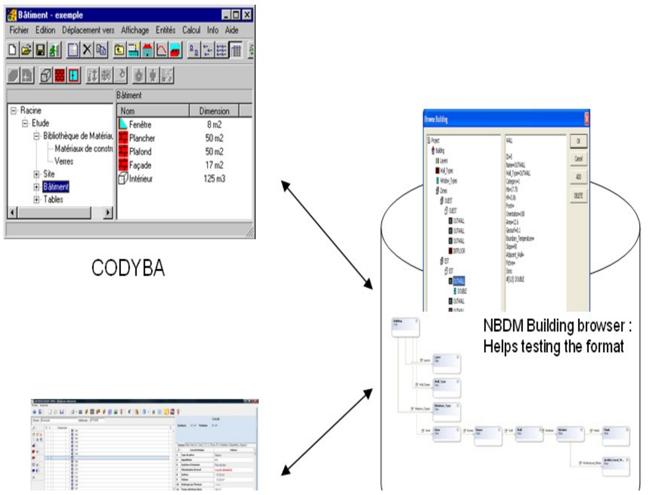

Figure 1: A very simple data model, using less than 20 classes, helped to connect France's major building simulation tools

We applied the same methodology to the NBDM1 model[2]. The results are quite comparable: 42% of input/output data can be defined in IFC and 23% could be derived from it.

Without considering attributes related to shading effects, the value rise up to 80%. This is probably because the description of shading effects in the simulation tools is still drawing based. A BIM based solution should be quite different and more efficient (Bedrune et al, 1999) (ECOTECT 2007).

2.1 *NBDM 1, gbXML and IFC*

NBDM 1 and gbXML are both focused on thermal simulation, but the business need is different: NBDM 1 has been developed to share data between several tools that could be used to evaluate the same project; gbXML is a support to exchange data between CAD tools and one Web based solution capable of evaluating energy consumptions and CO2 use of the building. Archicad and Revit Architecture are proposed as add-ons to perform simulations even when the level of definition of the project is very low during preliminary design.

We consider IFC as the most promising means to exchange between the CAD Architecture tools and the simulation tools because most of these tools import IFC and the quality of the interfaces is increasing. Due to the richness of the model, sometimes editors implement different solutions to the prejudice of interoperability. For crucial points, editor's agreements have already been defined. As an issue of the IAI meetings in Tokyo on 2008 April, it is expected to harmonize the way CAD tools define space boundaries.

[2] NBDM has been derived from data exchange capabilities between the 4 following tools: Climawin, Codyba, Comfie, Trnsys

The scope of NBDM is currently limited to the description of spaces, zones and the building elements which delimit them. NBDM does not deal with equipment, and simulation hypothesis like schedules and simulation results are not exchanged.

This type of information is part both of the gbXML and IFC data models. Thanks to the BS-8 project (IAI 2001), the IFC model integrates a time series concept, convenient for schedules and simulation results, as well as the capability to describe the performance of one instance over time.

2.2 *How to bridge the gap between IFC and simulation tools*

The Climawin software by BBS provides interesting functionalities:

1. IFC import
2. Definition of zones from spaces
3. 2D and 3D viewer
4. IFC and NBDM trees viewer
5. Calculation of walls and slabs areas from data about space boundaries.
6. NBDM1 Export

Using both the IFC and NBDM 1 format, we succeeded in transferring data between CAD tools like Archicad and simulation tools like TRNSYS.. order to allow free connections between the tools exchanging through NBDM, we plan to develop a module that could act as a bridge between IFC and the future next release of NBDM.

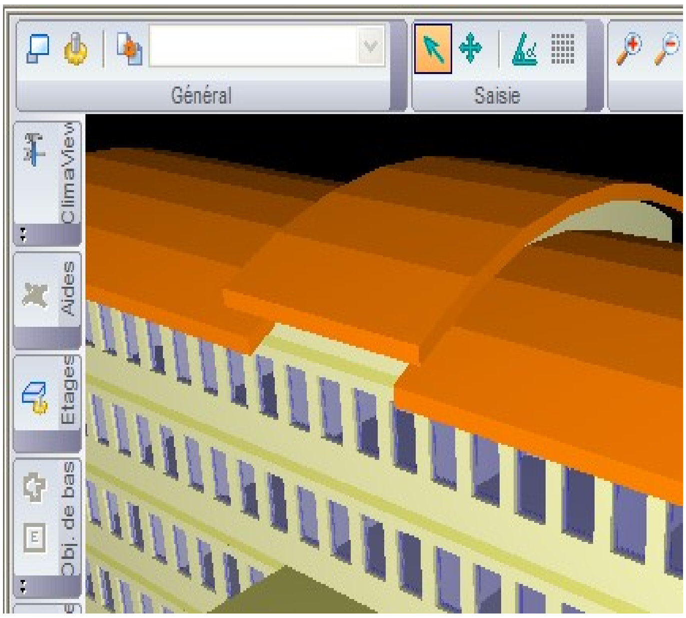

Figure 2: A CAD representation of a building in ClimaWin

NBDM Class	Total attributes NBDM	Information defined in IFC	Information derived from IFC	Information can not be defined in IFC	Information sometimes defined in IFC
Project	1	1	0	0	0
Building	7	4	2	1	0
Wall_Type	6	3	1	2	0
Layer	5	4	1	0	0
Window_Type	8	5	1	2	0
Zone	4	3	1	0	0
Room	4	2	2	0	0
Wall	13	3	5	5	0
Window	8	5	2	1	0
Mask	11	0	1	10	0
Architectural_Mask	4	0	0	4	0
	71	**30**	**16**	**25**	**0**
		42%	23%	35%	0%
		65%		35%	

Figure 3: Evaluation of the mapping between NBDM and IFC

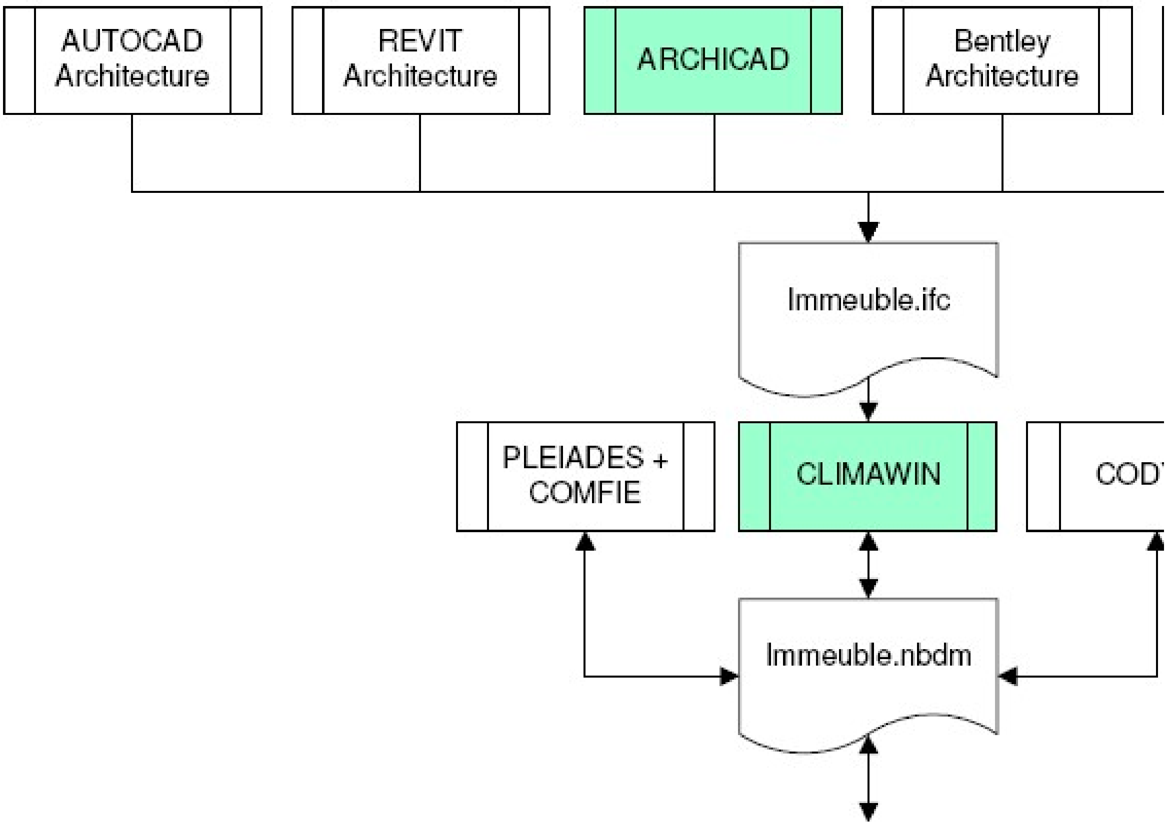

Figure 4: The path from CAD tools to simulation tools

3 NBDM AND CAD TOOLS

In parallel, approaches to create direct links from existing CAD packages to NBDM are currently under way, thus providing space boundary information directly (while IFC still works on the definition of a homogenous approach between different editors). A first implementation has created an NBDM-based bridge between the CAD tool NOVA of the Swiss company PLANCAL and the Codyba building simulation tool, using NBDM – and thus between this CAD tool and all tools supporting NBDM. This work [14], conducted by J. NOEL of JNLOG in collaboration with J.-J. ROUX of INSA Lyon, gave birth to the current NBDM 1.2, which includes a simple, vector-based geometry, allowing to preserve the graphical aspect of the building description.

3.1 *Exporting CAD data to NBDM*

The Swiss based company PLANCAL develops the NOVA software suite, a global solution for building related technical computing, including both a CAD interface and computational modules. The software is based on a stand-alone CAD tool developed in-house. NOVA targets thermal consulting companies.

The company has developed a module allowing exporting CAD data to the German ROWA software, a building code tool compliant with DIN 18599. The exported data includes the geometrical description of the building envelope, the composition and the thermal properties of the walls and windows. The exported file uses XML syntax.

As the data model used in this scenario is very close to the NBDM data model, it was possible to implement a translator from the ROWA format to the NBDM format with an effort of only two man-month. The implementation should however bee seen as a proof of concept, as the data format of the ROWA tool will still evolve. The results of the first experimentations already show that this approach can be successfully used.

3.2 *Importing CAD data into CODYBA via NBDM*

In parallel to the development of the NOVA to NBDM translator, a 3D modeler has been developed by JNLOG. It is designed for quick input of simple building geometries for studies in early project phases, using a limited number of primitives. The goal of this project is to further encourage the use of the NBDM data model. As the implementation of 3D modelers is quite costly, NBDM allows to link up to existing CAD tools at a negligible cost – this type of tools could even be distributed for free.

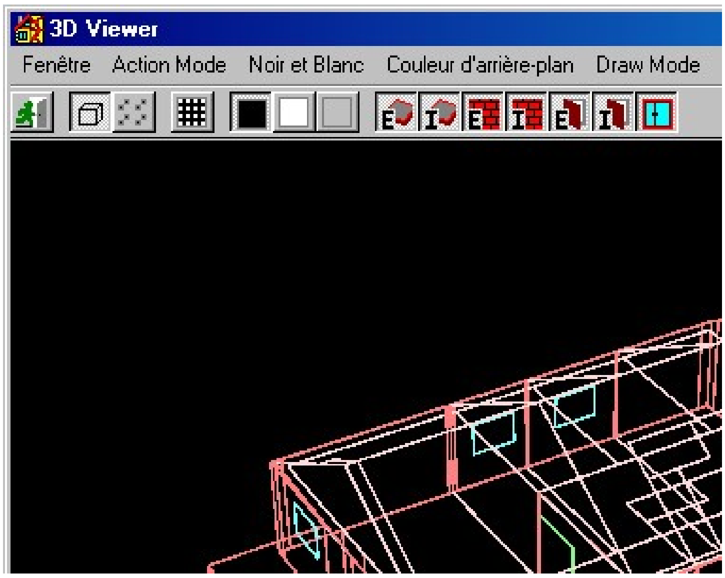

Figure 5: Example of an NBDM 1.2 file generated from NOVA data and imported into CODYBA's KoZiBu module

4 FUTURE WORK

This article explained the scope and first applications of the Neutral Building Data Model NBDM 1.0, as well as its first extension including notions of geometry, NBDM 1.2.

Although originally conceived for thermal building simulation tools, the NBDM is a neutral data model representing a building in a quite generic way; it can be envisaged to apply it to other domains where tools operate on a similar data model (acoustics, lighting, environmental characteristics, etc.). While NBDM 1 mainly focused on the topology of the building by defining (among other things) an adjacency graph, future version should include basic notions of geometry. This need arises from the current evolution of the main building simulation tools using NBDM: while the current generation of these tools uses a very approximate notion of geometry (orientation and surfaces), the current developments aim at integrating detailed geometry (shading, self-shading, masks). At the same time, adding geometry allows for more advanced coupling with CAD tools.

The goal of NBDM 2, which is currently being drafted, should be to go beyond the logical description of adjacencies to include detailed, but neutral geometry, again in an as straightforward as possible way. The approach indeed faces the danger of gaining in complexity as new concepts are added, thus risking to loose its current main asset: the simplicity which makes it easy to understand and cheap to implement.

The data model should continue to navigate in the gray zone between the application scenarios covered by the IFC on the top end and the sheer absence of any well defined communication mechanisms at the low end. Where the IFC data model defines the SpaceBoundary concept to map geometries of arbitrary complexity, even allowing for different types of geometry (but leaving to the discretion of the software editor to actually use these attributes), NBDM must define only the essentials of a three dimensional representation of a building for simulation – but require that these attributes be used in the semantics of building simulation (an not in a generic way).

Other possible future NBDM extensions include

- Additional connections to CAD tools and 3D building modelers
- Neutral, interoperable building element libraries / catalogs? (windows, walls, …)
- Extend the group
  - To more software editors
  - To other types of tools
  - On a European level
- Extension to include equipment (such as heating/cooling systems)

5 CONCLUSION

While the IFC approach remains the most efficient way to exchange data between software tools, the NBDM finds its justification in the fact that it fills still existing gaps not (yet) covered by IFC – be it due to lacking implementation or specificities of the business process. Future versions of the NBDM must aim at filling these gaps, without invading the space already occupied by the IFC – indeed, once the 'NBDM glue' has filled all these spaces, it may actually in the distant future merge into the IFC data model.

6 REFERENCES

BS-8 project: HVAC Extension Schemata for Modelling and Simulation, IAI, http://ce.vtt.fi/iaiIFCprojects/ShowProjectInfo.jsp?project_id=3&status_id=3, 2001.

ECOTECT 2007. http://www.squ1.com/ecotect

Green Building Studio. http://www.greenbuildingstudio.com/gbsinc/index.aspx

Ferriès B. 2002. Faciliter l'usage des logiciels de simulation grâce aux échanges d'objets IFC, Conférence IBPSA. http://www.laurenti.com/publis/Laurenti_IBPSA2002.pdf

Ferriès B. 2004. Les derniers progrès en matière d'interopérabilité entre logiciels de description du projet et outils de simulation, Société Française de Thermique, Toulouse.

Keilholz W. 2007. NBDM: A neutral data model to link building energy performance simulation tools, www.buildingsmart.fr/documents/stand-inn-sophia-antipolis/09_nbdm.pdf

Jammet V., Fouquet D., Keilhloz W., Mikolasek R., Noel J., Salomon T. 2006. Simulation dynamique, calculs réglementaires : vers une communication simplifiée. Rapport final du contrat Ademe 05 04 C 0112 du 20/04/06

Treldal N. 2008. Integrated Data and Process Control During BIM Design - Focused on Integrated Design of Energy and Indoor Climate Conditions Master's Thesis (http://masters.3dprojektering.dk/)

Bedrune J.P., Duffau P., Ferries B., Rocca F.X. 1999. Automatisation du traitement des masques solaires en amont de TRNSYS, 2ème séminaire TRNSYS francophone, MONTREAL (http://www.laurenti.com/publis/masques.PDF)

Keilholz W., Bedrune J-P, Ferriès B. 1998. Couplage entre outils de CAO et outils de simulation de bâtiments : une nouvelle approche dans la technologie des environnements de simulation et son application à TRNSYS. SOPHIA ANTIPOLIS. http://www.laurenti.com/publis/cadsim.PDF

IFC 2x3 TC1, 2007. Last release of IFC http://www.iai-tech.org/downloads/ifc/ifc2x3tc/

TRNSYS 16 – A TRANsient SYStem simulation program; The TRNSYS Group, Madison, 2006 - http://sel.me.wisc.edu/trnsys

Modes de saisie et de traitement des données d'un bâtiment en vue de la simulation thermique dynamique (travail de fin d'études, INSA de Lyon), M. GIRAULT et C. LEBRET, Mai 2008 http://www.jnlog.com/pdf/PIRD_Girault_Lebret.pdf

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